



**ANSI C12.22-2008**

**American National Standard  
Protocol Specification  
For  
Interfacing to Data  
Communication Networks**





**ANSI C12.22-2008**

**American National Standard**

**Protocol Specification  
For  
Interfacing to Data Communication Networks**

Secretariat:

**National Electrical Manufacturers Association**

Approved January 9, 2009

**American National Standards Institute, Inc.**

## NOTICE AND DISCLAIMER

The information in this publication was considered technically sound by the consensus of persons engaged in the development and approval of the document at the time it was developed. Consensus does not necessarily mean that there is unanimous agreement among every person participating in the development of this document.

NEMA standards and guideline publications, of which the document contained herein is one, are developed through a voluntary consensus standards development process. This process brings together volunteers and/or seeks out the views of persons who have an interest in the topic covered by this publication. While NEMA administers the process and establishes rules to promote fairness in the development of consensus, it does not write the document and it does not independently test, evaluate, or verify the accuracy or completeness of any information or the soundness of any judgments contained in its standards and guideline publications.

NEMA disclaims liability for any personal injury, property, or other damages of any nature whatsoever, whether special, indirect, consequential, or compensatory, directly or indirectly resulting from the publication, use of, application, or reliance on this document. NEMA disclaims and makes no guaranty or warranty, express or implied, as to the accuracy or completeness of any information published herein, and disclaims and makes no warranty that the information in this document will fulfill any of your particular purposes or needs. NEMA does not undertake to guarantee the performance of any individual manufacturer or seller's products or services by virtue of this standard or guide.

In publishing and making this document available, NEMA is not undertaking to render professional or other services for or on behalf of any person or entity, nor is NEMA undertaking to perform any duty owed by any person or entity to someone else. Anyone using this document should rely on his or her own independent judgment or, as appropriate, seek the advice of a competent professional in determining the exercise of reasonable care in any given circumstances. Information and other standards on the topic covered by this publication may be available from other sources, which the user may wish to consult for additional views or information not covered by this publication.

NEMA has no power, nor does it undertake to police or enforce compliance with the contents of this document. NEMA does not certify, test, or inspect products, designs, or installations for safety or health purposes. Any certification or other statement of compliance with any health or safety-related information in this document shall not be attributable to NEMA and is solely the responsibility of the certifier or maker of the statement.

# AMERICAN NATIONAL STANDARD

Approval of an American National Standard requires verification by ANSI that the requirements for due process, consensus, and other criteria for approval have been met by the standards developer.

Consensus is established when, in the judgment of the ANSI Board of Standards Review, substantial agreement has been reached by directly and materially affected interests. Substantial agreement means much more than a simple majority, but not necessarily unanimity. Consensus requires that all views and objections be considered, and that a concerted effort be made toward their resolution.

The use of American National Standards is completely voluntary; their existence does not in any respect preclude anyone, whether he has approved the standards or not, from manufacturing, marketing, purchasing, or using products, processes, or procedures not conforming to the standards.

The American National Standards Institute does not develop standards and will in no circumstances give an interpretation of any American National Standard. Moreover, no person shall have the right or authority to issue an interpretation of an American National Standard in the name of the American National Standards Institute. Requests for interpretations should be addressed to the secretariat or sponsor whose name appears on the title page of this standard.

**Caution Notice:** This American National Standard may be revised or withdrawn at any time. The procedures of the American National Standards Institute require that action be taken periodically to reaffirm, revise, or withdraw this standard. Purchasers of American National Standards may receive current information on all standards by calling or writing the American National Standards Institute.

Published by

**National Electrical Manufacturers Association  
1300 North 17th Street, Rosslyn, VA 22209**

© Copyright 2008 by National Electrical Manufacturers Association  
All rights reserved including translation into other languages, reserved under the Universal Copyright Convention, the Berne Convention for the Protection of Literary and Artistic Works, and the International and Pan American Copyright Conventions.

No part of this publication may be reproduced in any form, in an electronic retrieval system or otherwise, without the prior written permission of the publisher.

Printed in the United States of America

**This page intentionally left blank.**

## Contents

	<b>Page</b>
<b>1 SCOPE.....</b>	<b>1</b>
<b>2 REFERENCES .....</b>	<b>2</b>
2.1 NORMATIVE .....	2
2.2 OTHERS .....	4
<b>3 DEFINITIONS AND SYNTAX.....</b>	<b>4</b>
3.1 DEFINITIONS.....	4
3.1.1 <i>Absolute UID</i> .....	4
3.1.2 <i>ACSE</i> .....	4
3.1.3 <i>APDU Segment</i> .....	5
3.1.4 <i>Application Association</i> .....	5
3.1.5 <i>Application Context</i> .....	5
3.1.6 <i>Application Entity</i> .....	5
3.1.7 <i>Application Process</i> .....	5
3.1.8 <i>Application Protocol Data Unit (APDU)</i> .....	5
3.1.9 <i>ApTitle</i> .....	5
3.1.10 <i>Association</i> .....	5
3.1.11 <i>BER</i> .....	5
3.1.12 <i>Bit</i> .....	5
3.1.13 <i>Byte</i> .....	6
3.1.14 <i>C12.19 Device</i> .....	6
3.1.15 <i>C12.19 Device Class</i> .....	6
3.1.16 <i>C12.22 Application</i> .....	6
3.1.17 <i>C12.22 Authentication Host</i> .....	6
3.1.18 <i>C12.22 Client</i> .....	6
3.1.19 <i>C12.22 Communication Module</i> .....	6
3.1.20 <i>C12.22 Datagram Segmentation and Reassembly</i> .....	6
3.1.21 <i>C12.22 Device</i> .....	6
3.1.22 <i>C12.22 Gateway</i> .....	6
3.1.23 <i>C12.22 Host</i> .....	7
3.1.24 <i>C12.22 Master Relay</i> .....	7
3.1.25 <i>C12.22 Message</i> .....	7
3.1.26 <i>C12.22 Network</i> .....	7
3.1.27 <i>C12.22 Network Segment</i> .....	7
3.1.28 <i>C12.22 Node</i> .....	7
3.1.29 <i>C12.22 Notification Host</i> .....	7
3.1.30 <i>C12.22 Relay</i> .....	7
3.1.31 <i>C12.22 Server</i> .....	7
3.1.32 <i>Called ApTitle</i> .....	7
3.1.33 <i>Calling ApTitle</i> .....	7
3.1.34 <i>Channel</i> .....	7
3.1.35 <i>Cipher</i> .....	8
3.1.36 <i>Cipher, Inverse</i> .....	8
3.1.37 <i>Ciphertext</i> .....	8
3.1.38 <i>Cleartext</i> .....	8
3.1.39 <i>Connection</i> .....	8
3.1.40 <i>Datagram</i> .....	8
3.1.41 <i>EPSEM</i> .....	8
3.1.42 <i>Fragment</i> .....	8

3.1.43	<i>Interface</i> .....	8
3.1.44	<i>Local Port</i> .....	8
3.1.45	<i>Octet</i> .....	8
3.1.46	<i>Other Device</i> .....	8
3.1.47	<i>Plaintext</i> .....	8
3.1.48	<i>PSEM</i> .....	8
3.1.49	<i>Relative UID</i> .....	9
3.1.50	<i>Segment</i> .....	9
3.1.51	<i>Segmentation</i> .....	9
3.1.52	<i>Session</i> .....	9
3.1.53	<i>Transaction</i> .....	9
3.1.54	<i>UID</i> .....	9
3.2	DOCUMENT SYNTAX .....	9
3.3	TABLE SYNTAX.....	10
<b>4</b>	<b>REFERENCE TOPOLOGY.....</b>	<b>10</b>
<b>5</b>	<b>C12.22 NODE TO C12.22 NETWORK SEGMENT DETAILS .....</b>	<b>12</b>
5.1	C12.22 NODE TO C12.22 NETWORK SEGMENT REFERENCE .....	12
5.2	DATA ENCODING RULES.....	12
5.2.1	<i>Data order</i> .....	12
5.2.2	<i>Length Fields Encoding</i> .....	13
5.2.3	<i>Universal Identifiers Encoding</i> .....	13
5.2.4	<i>Universal Identifiers Canonical Encoding</i> .....	15
5.3	LAYER 7—APPLICATION LAYER .....	15
5.3.1	<i>Data Structure—Utility Industry Data Tables</i> .....	15
5.3.2	<i>EPSEM</i> .....	15
5.3.2.1	Request Codes.....	16
5.3.2.2	Response Codes .....	16
5.3.2.3	Time-out.....	19
5.3.2.3.1	Session Time-out .....	19
5.3.2.3.2	Application Layer Response Time-out .....	20
5.3.2.4	Services.....	20
5.3.2.4.1	Identification Service.....	20
5.3.2.4.2	Read Service .....	23
5.3.2.4.3	Write Service .....	25
5.3.2.4.4	Logon Service.....	26
5.3.2.4.5	Security Service .....	27
5.3.2.4.6	Logoff Service .....	28
5.3.2.4.7	Terminate Service .....	28
5.3.2.4.8	Disconnect Service .....	29
5.3.2.4.9	Wait Service.....	30
5.3.2.4.10	Registration Service .....	30
5.3.2.4.11	Deregistration Service.....	37
5.3.2.4.12	Resolve Service.....	37
5.3.2.4.13	Trace Service .....	38
5.3.2.5	Service sequence state control .....	39
5.3.2.6	Partial Table access using index/element-count Method .....	41
5.3.2.7	Partial Table access using offset/octet-count method .....	43
5.3.3	<i>EPSEM Envelope Structure</i> .....	44
5.3.4	<i>Association Control—Association Control Service Element (ACSE)</i> .....	45
5.3.4.1	Application Context Element ( $A1_H$ ) .....	46
5.3.4.2	Called AP Title Element ( $A2_H$ ).....	47
5.3.4.3	Calling AP Title Element ( $A6_H$ ).....	47
5.3.4.4	Universal Identifier of Called and Calling AP Title Element ( $06_H$ ) .....	47
5.3.4.5	Relative Universal Identifier of Called and Calling AP Title Element ( $80_H$ ) .....	48
5.3.4.6	Calling Application Entity Qualifier Element ( $A7_H$ ) .....	48
5.3.4.7	Mechanism Name Element ( $8B_H$ ) .....	49

5.3.4.8	Calling Authentication Value Element (AC <sub>H</sub> ) .....	49
5.3.4.8.1	C12.22 Security Mechanism (<application-context-oid>.2.1).....	51
5.3.4.8.2	C12.21 Security Mechanism (<application-context-oid>.2.0).....	53
5.3.4.8.3	C12.22 Other Security Mechanisms .....	55
5.3.4.9	Called AP Invocation ID Element (A4 <sub>H</sub> ) .....	56
5.3.4.10	Calling AP Invocation ID Element (A8 <sub>H</sub> ).....	56
5.3.4.11	User Information Element (BE <sub>H</sub> ) .....	58
5.3.4.12	Use of Subbranches of a Registered ApTitle .....	59
5.3.4.13	C12.22 Security Mechanism.....	63
5.3.4.13.1	C12.22 Security Mechanism (<application-context-oid>.2.1).....	64
5.3.5	<i>Application Segmentation Sub-layer</i> .....	70
5.3.5.1	APDU Segmentation.....	71
5.3.5.2	APDU Segment.....	71
5.3.5.2.1	Called AE Qualifier Element (A3 <sub>H</sub> ).....	71
5.3.5.2.2	Segment User Information Element (BE <sub>H</sub> ) .....	72
5.3.5.2.2.1	Segment Association Information Element .....	72
5.3.5.2.2.2	Segment Data Elements.....	72
5.3.5.3	The Segmentation and Reassembly .....	73
5.3.5.3.1	The Segmentation Algorithm.....	73
5.3.5.3.2	The Reassembly Algorithm .....	74
5.4	LAYER 6—PRESENTATION LAYER .....	75
5.5	LAYER 5—SESSION LAYER .....	75
5.6	LAYER 4—TRANSPORT LAYER .....	76
5.7	LAYER 3—NETWORK LAYER .....	76
5.8	LAYER 2—DATA LINK LAYER.....	76
5.9	LAYER 1—PHYSICAL LAYER .....	76

## 6 PROTOCOL DETAILS: C12.22 DEVICE TO C12.22 COMMUNICATION MODULE INTERFACE 77

6.1	INTERFACE ARCHITECTURE .....	77
6.2	INTERFACE DIAGRAM .....	77
6.3	IMPLEMENTATION GUIDELINES .....	78
6.3.1	<i>C12.22 Communication Module</i> .....	78
6.3.2	<i>C12.22 Device</i> .....	79
6.4	LAYER 7—APPLICATION LAYER .....	79
6.5	LAYER 6—PRESENTATION LAYER .....	80
6.6	LAYER 5—SESSION LAYER .....	80
6.7	LAYER 4—TRANSPORT LAYER .....	80
6.7.1	<i>Negotiate Service</i> .....	80
6.7.2	<i>Get Configuration Service</i> .....	82
6.7.3	<i>Link Control Service</i> .....	85
6.7.4	<i>Send Message Service</i> .....	87
6.7.5	<i>Get Status Service</i> .....	88
6.7.6	<i>Get Registration Status Service</i> .....	89
6.7.7	<i>Service Time Sequence Diagrams</i> .....	91
6.7.8	<i>Service Sequence States</i> .....	94
6.8	LAYER 3—NETWORK LAYER .....	96
6.9	LAYER 2—DATA LINK LAYER .....	96
6.9.1	<i>Basic Data Information</i> .....	97
6.9.1.1	Fixed Settings .....	97
6.9.1.2	Variable Settings .....	97
6.9.2	<i>Packet Definition</i> .....	97
6.9.3	<i>CRC Selection</i> .....	99
6.9.4	<i>Acknowledgment</i> .....	99
6.9.5	<i>Retry Attempts</i> .....	100
6.9.6	<i>Timeouts</i> .....	100
6.9.6.1	Traffic Time-out.....	100
6.9.6.2	Inter-character Time-out .....	100

6.9.6.3	<i>Response Time-out</i>	100
6.9.7	<i>Turn Around Delay</i>	100
6.9.8	<i>Collision</i>	100
6.9.9	<i>Duplicate Packets</i>	101
6.9.10	<i>Transparency</i>	101
6.9.11	<i>Supervision of the Communications Link</i>	101
6.9.12	<i>Local Routing</i>	101
6.9.13	<i>Service Sequence States</i>	103
6.10	LAYER 1—PHYSICAL LAYER	104
6.10.1	<i>Signal Definition</i>	104
6.10.2	<i>Electrical Properties of Connection</i>	104
6.10.3	<i>Mechanical and Environmental Properties</i>	105
6.10.4	<i>Supervision of the Communications Link</i>	106
<b>7</b>	<b>LOCAL PORT COMMUNICATION PROTOCOL DETAILS</b>	<b>107</b>
7.1	PROTOCOL DEFINITION	107
7.1.1	<i>Layer 7—Application Layer</i>	107
7.1.2	<i>Layer 6—Presentation Layer</i>	107
7.1.3	<i>Layer 5—Session Layer</i>	107
7.1.4	<i>Layer 4—Transport Layer</i>	107
7.1.5	<i>Layer 3—Network Layer</i>	108
7.1.6	<i>Layer 2—Data Link Layer</i>	108
7.1.7	<i>Layer 1—Physical Layer</i>	108
7.2	C12.22 LOCAL PORT COMMUNICATION USING A C12.18 OPTICAL PORT	108
7.2.1	<i>Establishment of ANSI C12.18 Protocol Compatibility Mode</i>	109
7.2.2	<i>Establishment of ANSI C12.22 Protocol Compatibility Mode</i>	109
<b>8</b>	<b>BACKWARD COMPATIBILITY</b>	<b>110</b>
<b>9</b>	<b>COMPLIANCE</b>	<b>111</b>
<b>ANNEX A—RELAYS</b>		<b>112</b>
A.1	HIERARCHICAL TOPOLOGY	112
A.2	C12.22 MASTER RELAYS	112
A.3	REGISTRATION NOTIFICATION	113
A.4	REGISTRATION ALGORITHM DETAILS	113
A.5	C12.22 NODE APTITLE AUTO-ASSIGNMENT	113
A.6	C12.22 MASTER RELAY APITLE AUTO-ASSIGNMENT	114
A.7	OBSOLETE ROUTES	114
A.8	MULTIPLE ROUTES	114
A.9	APPLICATION LAYER SUPERVISION	114
A.10	ROUTING	115
<b>ANNEX B—ROUTING EXAMPLES</b>		<b>116</b>
B.1	C12.22 RELAYS WITH A SINGLE SERVICE PROVIDER	116
B.2	C12.22 RELAYS SHARED BY MULTIPLE SERVICE PROVIDERS	116
<b>ANNEX C—MODIFICATIONS AND EXTENSIONS TO C12.19-1997</b>		<b>118</b>
C.1	DECade 12: NODE NETWORK CONTROL TABLES	119
	<i>TABLE 120 Dimension Network Table</i>	119
	<i>TABLE 121 Actual Network Table</i>	123
	<i>TABLE 122 Interface Control Table</i>	126
	<i>TABLE 123 Exception Report Configuration Table</i>	129
	<i>TABLE 124 Filtering Rules Table</i>	131
	<i>TABLE 125 Interface Status Table</i>	133

<i>TABLE 126 Registration Status Table.....</i>	138
<i>TABLE 128 Network Statistics Table .....</i>	141
C.2 DECADE 130—RELAY CONTROL TABLES .....	143
<i>TABLE 130 Dimension Relay Table .....</i>	143
<i>TABLE 131 Actual Relay Table.....</i>	145
<i>TABLE 132 Registration List Table.....</i>	146
<i>TABLE 133 Static Routing Table.....</i>	149
<i>TABLE 134 Host Notification Table.....</i>	151
<i>TABLE 135 Master Relay Assignment Table.....</i>	154
<i>TABLE 136 Dynamic Routing Report Table .....</i>	155
C.3 UNIVERSAL ID PATTERN DESCRIPTION OF AP TITLES .....	156
C.4 ADDITIONS TO TABLE 07—PROCEDURE INITIATE TABLE.....	157
<i>PROCEDURE 23 Register .....</i>	157
<i>PROCEDURE 24 Deregister.....</i>	157
<i>PROCEDURE 25 Network Interface Control .....</i>	157
<i>PROCEDURE 26 Exception Report.....</i>	158
C.5 TABLE 46: EXTENDED KEY TABLE .....	160
C.6 TABLE 47 HOST ACCESS SECURITY TABLE .....	162
<b>ANNEX D—UNIVERSAL IDENTIFIER.....</b>	<b>166</b>
<b>ANNEX E—ONE-WAY DEVICES.....</b>	<b>168</b>
<b>ANNEX F—APDU RESPONSE TIMEOUT ALGORITHM .....</b>	<b>170</b>
<b>ANNEX G—COMMUNICATION EXAMPLE .....</b>	<b>172</b>
EXAMPLE #1: UNSECURED SESSION.....	172
EXAMPLE #2: UNSECURED SESSIONLESS .....	173
EXAMPLE #3: UNSECURED NOTIFICATION .....	174
EXAMPLE #4: AUTHENTICATED SESSION .....	174
EXAMPLE #5: AUTHENTICATED SESSIONLESS.....	176
EXAMPLE #6: AUTHENTICATED NOTIFICATION.....	178
EXAMPLE #7: ENCRYPTED SESSION .....	178
EXAMPLE #8: ENCRYPTED SESSIONLESS.....	182
EXAMPLE #9: ENCRYPTED NOTIFICATION.....	183
<b>ANNEX H—CRC EXAMPLES.....</b>	<b>185</b>
H.1 TRACE .....	185
H.2 CRC CODE EXAMPLE .....	186
<b>ANNEX I—THE EAX' CRYPTOGRAPHIC MODE .....</b>	<b>187</b>
I.1 EAX' DESCRIPTION .....	187
I.2 JUSTIFICATIONS FOR SELECTION OF EAX RATHER THAN CCM (INFORMATIVE) .....	191
I.3 JUSTIFICATIONS FOR THE EAX' OPTIMIZATIONS.....	192
I.4 EAX' C CODE EXAMPLE (INFORMATIVE) .....	195
I.5 AES C CODE EXAMPLE (INFORMATIVE) .....	199
<b>ANNEX J – CONNECTIONLESS-ACSE-1 EQUIVALENT REDUCED SYNTAX FOR C12.22 MESSAGE TRANSMISSION .....</b>	<b>204</b>

**Foreword** (This Foreword is not part of American National Standard C12.22-2008.)

This Standard is another in the series of communications protocols that describe how to transport Tables (defined in ANSI C12.19, "Utility Industry End Device Data Tables"). Because this Standard describes a protocol that operates over networks, it is necessarily more complex than the simple point-to-point protocols defined in ANSI C12.18 and ANSI C12.21, but the committee has done as much as practical to smooth the transition from those earlier standards.

This Standard describes three different but related uses. One is the operation of the protocol over the network that all C12.22 Nodes implement. The second is an optionally exposed point-to-point interface between a C12.22 Device, e.g., a meter, and, a C12.22 Communications Module, e.g., a network adaptor. The third is the capture, translation and transmission of one way device messages (blurts).

This division was chosen to foster interoperability among communications modules and meters. Suggestions for improvement to this Standard are welcome. They should be sent to:

National Electrical Manufacturers Association  
Vice President, Technical Services  
1300 North 17th Street  
Suite 1752  
Rosslyn, VA 22209

This Standard was processed and approved for submittal to ANSI by Accredited Standards Committee for Electricity Metering C12. At the time the committee approved this Standard, the C12 Committee had the following members:

**Tom Nelson, Chairman**  
**Paul Orr, Secretary—NEMA Staff**

<i>Name of Representative:</i>	<i>Organization Represented:</i>
Larry Barto	Georgia Power
Ron Breschini	Underwriters Laboratories, Inc.
Brent Cain	Itron, Inc.
Curt Crittenden	GE Energy
Jim DeMars	Florida Power & Light Co.
David Ellis	Public Service Electric & Gas
Tim Everidge	Radian Research, Inc.
Shawn Glasgow	Milbank Manufacturing
Bill Hardy	Technology for Energy Corporation
Bob Hughes	Schweitzer Engineering Labs, Inc.
Brad Johnson	Oncor Group
Lawrence Kotewa	Center for Neighborhood Technology
Herman Millican	Austin Energy
Avygdor Moise	Future DOS R&D Inc.
Tim Morgan	Duke Energy Company
Tom Nelson	Natl Inst. of Standards & Technology
D. Young Nguyen	Pacific Gas & Electric Company
Dan Nordell	Xcel Energy EMC
Dave Scott	Plexus
Aaron Snyder	EnerNex Corporation
George Steiner	Sensus Metering
Jim Thurber	Baltimore Gas & Electric Company
Richard Tucker	Tucker Engineering
Michel Veillette	Trilliant Networks, Inc.
John Voisine	Landis+Gyr
H.A. Wall	Watthour Engineering Co.

Scott Weikel  
James West

Elster Electricity  
Ameren

Working Group 1 of Subcommittee 17 that developed the Standard consisted of:

**Ed Berozet, Chairman**  
**Richard Tucker, Vice Chairman**  
**Michel Veillette, Editor**  
**Paul Orr, Secretary—NEMA Staff**

<i>Name of Representative:</i>	<i>Organization Represented:</i>
Michael Anderson	Landis+Gyr
Norbert Balko	Invensys Metering Systems
Ed Berozet	Elster Electricity
Bill Beverly	Austin International Inc.
William Buckley	Consultant for Itron, Inc
Martin Burns	Hypertek Inc. for EPRI
Brent Cain	Itron, Inc.
Richard Coblenz	Schlumberger Electricity
Raymond Gaudreault	C-MAC
Derek Gibbs	Smartsynch
Ken Gilmer	Itron, Inc.
Greg Gomez	Badger Meter
David Haynes	Aclara
Mark Iacoviello	Distribution Control Systems
Janice Jennings	Schlumberger Electricity
Jean Joly	Hydro-Quebec
Brad Johnson	Oncor
Lawrence Kotewa	Center for Neighborhood Technology
Jacques Ledoux	Trilliant Networks, Inc.
Keith Martin	Tantalus Systems Corp.
Peter Martin	Distribution Control Systems, Inc.
Ed May	Itron, Inc.
Bill Mazza	Invensys Metering Systems
Robert McMichael	Itron, Inc.
Avygdor Moise	Future DOS R&D Inc.
John Newbury	Open University
Dan Nordell	Northern States Power Co.
Vuong Nguyen	Measurement Canada
James Pace	Silver Springs Networks
Terry Penn	Southern Company
Marc Purc	Schlumberger
Bin Qiu	Landis+Gyr, Inc
Wesley Ray	Duke Energy Corp.
Jeff Richardson	Elster Metering
Bill Rush	IGT
Ruben Salazar	Landis+Gyr
Chris Schafer	Itron Inc.
Robby Simpson	GE Energy
Kendall Smith	Hexagram
Aaron Snyder	EnerNex Corporation
John Taylor	American Innovations
Richard Tucker	Tucker Engineering
Michel Veillette	Trilliant Networks, Inc.
Ted York	THY Consulting
Virginia Zinkowski	GE Energy

**This page intentionally left blank.**